

**APPLICATION FOR UNITED STATES PATENT  
IN THE NAME OF**

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for

**SEAT BELT MOUNTED AIR BAG PUNCTURE DEVICE**

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## SEAT BELT MOUNTED AIR BAG PUNCTURE DEVICE

### Background of the Invention

#### Area of the Art

The present invention relates to vehicle safety devices, and more particularly  
5 to a device which punctures an inflating air bag in controlled fashion so as to soften  
the surface of the inflating air bag and prevent injury to the vehicle occupant.

#### Description of the Prior Art

It is known in the art to provide arrangements for venting an inflating air  
bag to prevent injury to the vehicle occupant. Examples of such include U.S. Patent  
10 5,603,526 of Buchanan in which an air bag cushion has frangible vent coverings and  
vent openings which permit inflation gas to exit the cushion and provide the proper  
pressure reduction for preventing injury to the passenger. In U.S. Patent 5,725,244  
of Cundill, an air bag has a venting mechanism that allows inflation gas to vent  
from an inflation chamber through an expandable venting member. When the  
15 inflation pressure in the air bag reaches a preselected level, the frangible portion of  
the retaining member breaks and the venting member is expanded through the  
broken portion allowing the inflation gas to vent to the atmosphere.

Still other arrangements known in the art combine with a vehicle seat belt  
system to protect the vehicle occupant from injury. In U.S. Patent 6,273,467 of  
20 Berke et al., a surgical shield mounted on the shoulder strap of the seat belt system  
prevents rubbing of the strip on a sensitive or physically impaired body area such as  
a heart pacer, chest injuries, or the like. U.S. Patent 6,439,333 of Dömens et al.  
describes a sensor system for inflating an air bag in a differentiated way. The  
position of the vehicle occupant is determined by using the seat belt as an active  
25 reference position. The distance between the seat belt and known points within the  
vehicle determines the position of the seat belt and thus the vehicle occupant. U.S.  
Patent 6,557,895 of Haack et al. describes a protective pad similar to that described  
in U.S. Patent 6,273,467 of Berke et al. Similarly, U.S. Patent 6,576,808 of Dreyer

describes a protective device for a sensitive or vulnerable area of the chest of the seat belt wearer.

### Summary of the Invention

5 The present invention provides an air bag puncture device for controlled deflation of an inflating air bag. The puncture device comprises an element having at least one sharp point and an arrangement for mounting the device so that the at least one sharp point extends outwardly from the torso of a vehicle occupant and punctures an air bag upon inflation onto the torso of the occupant. The arrangement for mounting the device may include a vehicle seat belt and means for  
10 mounting the device on the seat belt. The device may include a clip for removably mounting the device on the seat belt.

The puncture device may include means for venting gas from the inflating air bag upon puncturing of the bag. The puncture device may also include apparatus for shielding the pointed tip except when the air bag inflates against the puncture  
15 device. The shielding apparatus is operative to shield the sharp point until an air bag inflates against the puncture device with a predetermined force.

In a preferred embodiment of an air bag puncture device according to the invention, a cylindrical cutting device has a serrated outer end and an opposite inner end mounted on a resilient clip for removably mounting the device on a  
20 vehicle seat belt. A spring loaded collar is slidably mounted on the cylindrical cutting device and includes a spring having a resilient resistance to sliding movement of the collar over the cutting device so as to define a predetermined amount of force exerted by an inflating air bag before the bag is punctured. Venting of gas from an inflating air bag upon puncturing of the bag is facilitated by a  
25 venting slot in the cylindrical cutting device and a vent hole in the spring loaded collar.

### Description of the Figures

FIGURE 1 is a front view of a vehicle occupant restrained by a shoulder belt having an air bag puncture device mounted thereon in accordance with the invention.

5        FIGURE 2 is a perspective view of the air bag puncture device of FIGURE 1.

FIGURE 3 is an exploded perspective view of a portion of the air bag puncture device of FIGURE 2 showing a venting slot and vent hole for venting escaping gas from a punctured air bag.

10       FIGURE 4 is a side view of a portion of the air bag puncture device of FIGURE 2 showing the manner in which a spring loaded collar normally shields a serrated outer end of a cylindrical cutting device.

15       FIGURE 5 is a side view similar to that of FIGURE 4 but showing the manner in which an inflating air bag overcomes the resistance of the spring loaded collar so that the serrated outer end of the cutting device is able to puncture the inflating air bag.

### Detailed Description of the Invention

20       Figure 1 is a representation of a vehicle occupant 10 wearing a seat belt system 12. Only a shoulder harness 14 of the seat belt system 12 is shown, inasmuch as that is the portion of the seat belt system 12 which extends across the torso 16 of the vehicle occupant 10. The shoulder harness 14 represents that of a driver of the vehicle, but the invention is equally applicable to passengers as well. The invention is applicable to any vehicle occupant who is protected by an air bag.

25       As shown in Figure 1, an air bag puncture device 18 in accordance with the invention is mounted on the shoulder harness 14. This is a convenient way of mounting the air bag puncture device 18 so that it extends from the torso 16 of the occupant 10. As described hereafter, the air bag puncture device 18 is removably mounted on the shoulder harness 14. However, other mounting arrangements can be used, so long as the air bag puncture device 18 is mounted in the region of the

torso 16 of the vehicle occupant 10 where it can engage and puncture an air bag upon inflation of the air bag into the vehicle occupant 10.

As shown in Figure 2, the air bag puncture device 18 is made removable by use of a resilient clip 20. The clip 20 has opposite facing portions 22 and 24 which are resiliently biased together. To mount the clip 20 on the shoulder harness 14, it is only necessary to separate the portions 22 and 24 against the resilient resistance of the clip 20 and slide the portions 22 and 24 over opposite sides of the shoulder harness 14. Once installed on the shoulder harness 14 in this fashion, the resilience of the clip 20 holds it in place.

The air bag puncture device 18 includes a cylindrical cutting device 26 which is best shown in Figure 3. The cutting device 26 is of hollow cylindrical configuration and has a serrated outer end 28 which terminates in a circular array of sharp points. The cutting device 26 has an end 30 opposite the outer end 28 which is mounted on the portion 22 of the resilient clip 20.

The air bag puncture device 18 has a spring loaded collar assembly 32 which includes a hollow cylindrical collar 34 having a coil spring 36 coupled to one end thereof. The cylindrical collar 34 is mounted for sliding movement along the outside of the cutting device 26. The coil spring 36 is also disposed around the outside of the cutting device 26 and extends between an inner end 38 of the cylindrical collar 34 and the portion 22 of the clip 20.

As shown in Figure 3, the air bag puncture device 18 has a venting arrangement for venting gas when an air bag is punctured, as described hereafter. The venting arrangement includes a venting slot 40 in a lower side of the cutting device 26, and a vent hole 42 in a lower side of the cylindrical collar 34.

Figure 4 shows the normal orientation of the air bag puncture device 18 when an air bag has not been deployed. To shield the vehicle occupant 10 and others from the sharp points of the serrated outer end 28 of the cutting device 26, the cylindrical collar 34 extends beyond the serrated outer end 28 so that an outer end 44 thereof is outside of the serrated outer end 28.

Figure 5 illustrates the manner in which the air bag puncture device 18 punctures an inflating air bag 46. As the air bag 46 inflates, it extends outwardly and into the region of the torso 16 of the vehicle occupant 10. It is well documented that vehicle air bags act to protect the vehicle occupants from serious injury. At the same time, however, the outer surface and other outer portions of the air bag tend to present a relatively hard outer surface of the air bag which can lead to facial and other bodily abrasions and other injuries. This occurs because the air bag inflates rapidly and with considerable force and presents a hard surface to the vehicle occupant 10 for a brief moment.

In accordance with the invention, the air bag puncture device 18 acts to puncture and partially deflate the inflating air bag 42 as it reaches the vehicle occupant 10. As a result, the outer portions of the inflating air bag 46 are greatly softened so as to minimize injury to the occupant 10. As the air bag 46 inflates, it strikes the outer end 40 of the cylindrical collar 34. Thereafter, the collar 34 slides along the cutting device 26 against the resistance of the coil spring 36. Eventually, the collar 34 reaches the position shown in Figure 5 in which the serrated outer end 28 of the cutting device 26 protrudes beyond the outer end 40 of the collar 34 and punctures the surface of the air bag 46. When this occurs, the air bag 46 begins to deflate.

To accommodate escaping gases from the deflating air bag 46, such gases flow into the hollow interior of the cutting device 26. From there, such gases flow through the venting slot 40 of the cutting device 26 and through the vent hole 42 in the cylindrical collar 34 to the outside of the air bag puncture device 18.

The inflating air bag 46 must overcome the resistance of the coil spring 36 so that the cylindrical collar 34 is pushed back to expose the serrated outer end 28 before the air bag 46 is punctured. The force needed to overcome the resistance of the coil spring 36 is predictable and provides the air bag puncture device 18 with a predetermined force characteristic for puncturing the air bag 46. This is important to the successful operation of the air bag puncture device 18. Premature puncturing

of the air bag 46 can result in a reduction in the overall effectiveness of the air bag 46. On the other hand, delayed puncturing of the air bag 46 as the result of too much force being needed to overcome the resistance of the coil spring 36 can result in the vehicle occupant 10 being struck by a hard outer surface of the air bag 46 and possibly sustaining injury. Puncturing of the air bag 46 at the right moment and by the desired amount allows the air bag 46 to maintain its overall effectiveness while at the same time softening the outer several inches of the air bag 46 so as to minimize or eliminate injury from engagement with the normally hard outer surface of the air bag 46.

It will be understood that air bag puncture devices in accordance with the invention can take on forms other than that shown and described herein while still achieving the advantages of the invention. The important consideration is that a pointed object be located at or in proximity to the torso of the vehicle occupant where the air bag comes in contact with the occupant upon deployment. Apart from that, features such as the known spring resistance and the venting effect provided by the particular embodiment of the air bag puncture device 18 disclosed herein can be employed to optimize the performance of air bag puncture devices according to the invention.